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Revision 4

# Annual Summary of the Integrated Disposal Facility Performance Assessment for 2004

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# Acronyms

| | |
|---|---|
| AGA | alternative generations analysis |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| DAS | Disposal Authorization Statement |
| DOE | U.S. Department of Energy |
| DOE/HQ | DOE Headquarters |
| EDE | effective dose equivalent |
| EIS | Environmental Impact Statement |
| EMSP | Environmental Management Science Program |
| EPA | U.S. Environmental Protection Agency |
| FY | fiscal year |
| IDF | Integrated Disposal Facility |
| IHLW | immobilized high-level waste |
| ILAW | immobilized low-activity waste |
| LFRG | Low-Level Waste Disposal Facility Federal Review Group |
| LLW | low-level waste |
| MLLW | mixed low-level waste |
| ORP | U.S. Department of Energy, Office of River Protection |
| PA | performance assessment |
| RCRA | Resource, Conservation, Recovery Act |
| R&D | research and development |
| ROD | Record of Decision |
| SAC | System Assessment Capability |
| TFC | Tank Farm Contractor |
| TFVZP | Tank Farm Vadose Zone Project |
| WTP | Waste Treatment and Immobilization Plant |

# Chemical Symbols

| | |
|---|---|
| I | iodine |
| Np | neptunium |
| Tc | technetium |

# Acknowledgements

This report is based on the work of the multi-laboratory staff engaged in the Integrated Disposal Facility Performance Assessment activity which was formerly the Immobilized Low-Activity Performance Assessment activity:

- Scott Finfrock, Raz Khaleel, Raymond Puigh, Paul Rittmann, and David Wootan (Fluor Federal Services)
- Diana Bacon, Mike Fayer, Charles Kincaid, Clark Lindenmeier, Shas Mattigod, Pete McGrail, Phil Meyer, Steve Reidel, Jeff Serne, and Ken Krupka (Pacific Northwest National Laboratory)
- Bill Ebert (Argonne National Laboratory)
- Dave Kaplan (Savannah River Technical Center).

The Immobilized Waste Project staff (Heather Baune, Dennis Carson, Kris Colosi, Dave Comstock, Dan Lucas, and Greg Parsons) also greatly aided the effort. Bob Bryce of the Pacific Northwest National Laboratory provided information about the System Assessment Capability.

Finally, Phil LaMont of the Office of River Protection carefully follows all the work of the IDF PA. He has provided many comments and guidance.

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# SUMMARY


As required by the U.S. Department of Energy (DOE) order on radioactive waste management (DOE 1999a) and as implemented by the *Maintenance Plan for the Hanford Immobilized Low-Activity Tank Waste Performance Assessment* (Mann 2004), an annual summary of the adequacy of the Hanford Immobilized Low-Activity Tank Waste Performance Assessment (ILAW PA) is necessary in each year in which a performance assessment is not issued. A draft version of the 2001 ILAW PA was sent to the DOE Headquarters (DOE/HQ) in April 2001 for review and approval. The DOE approved (DOE 2001) the draft version of the 2001 ILAW PA and issued a new version of the Hanford Site waste disposal authorization statement (DAS). Based on comments raised during the review, the draft version was revised and the 2001 ILAW PA was formally issued (Mann et al. 2001). The DOE (DOE 2003a) has reviewed the final 2001 ILAW PA and concluded that no changes to the DAS were necessary.

Also as required by the DOE order, annual summaries have been generated and approved. The previous annual summary (Mann 2003b) noted the change of mission from ILAW disposal to the disposal of a range of solid waste types, including ILAW. DOE approved the annual summary (DOE 2003c), noting the expanded mission.

Considering the results of data collection and analysis, the conclusions of the 2001 ILAW PA remain valid as they pertain to ILAW disposal. The new data also suggest that impacts from the disposal of the other solid waste will be lower than initially estimated in the *Integrated Disposal Facility Risk Assessment* (Mann 2003a). A performance assessment for the Integrated Disposal Facility (IDF) will be issued in the summer of 2005.


## A. STATUS OF ILAW PA

Considering the results of data collection and analysis, the conclusions of the 2001 ILAW PA remain valid as they pertain to ILAW disposal.

## B. NEW AND PENDING DOE DECISIONS

### 1. Solid Waste Environmental Impact Statement Record of Decision

The 2003 Annual Summary (Mann 2003b) noted that the mission of the ILAW disposal facility had transformed into a disposal facility not only for ILAW disposal, but also for the disposal of other Hanford Site and DOE complex low-level and mixed low-level waste. This new facility is called the Integrated Disposal Facility. This change has been formalized by the "Record of Decision for the Solid Waste Program, Hanford Site, Richland, WA: Storage and Treatment of Low-Level Waste and Mixed Low-Level Waste; Disposal of Low-Level Waste and Mixed Low-Level Waste, and Storage, Processing, and Certification of Transuranic Waste for Shipment to the Waste Isolation Pilot Plant," (DOE 2004a) that was based on the corresponding environmental impact statement (DOE 2004b).

The IDF will be the disposal facility not only for ILAW, but also for other waste destined for Hanford's Solid Waste Burial Grounds after 2005/6. Disposal of this other waste (Hanford Site solid low-level radioactive waste including secondary waste generated during the production of ILAW and immobilized high-level waste (IHLW) as well as solid low-level radioactive waste sent by other DOE sites) has been covered by the maintenance activities for the Hanford Solid Waste Burial Grounds Performance Assessment, the last annual summary being *Performance Assessment Review Report, 2001-2002, Annual Review of the 200 West and 200 East Area Performance Assessments* (Van Leuven 2003). This IDF annual summary report and future IDF performance assessment actions will cover all waste to be disposed in the IDF.

The major source of estimated groundwater impacts for the expanded mission comes not from the ILAW packages analyzed in the 2001 ILAW PA, but from the secondary waste from ILAW and IHLW production. The *Integrated Disposal Facility Risk Assessment* (Mann et al. 2003a, also attached as Appendix A to the 2003 Annual Summary (Mann 2003b) shows that the long-term performance of this facility easily meets the performance objectives set for the 2005 ILAW PA (Mann 2002b).

## 2. Tc Separation in WTP

The DOE's Office of River Protection (ORP) has eliminated the Tc (technetium) separations process from the Waste Treatment and Immobilization Plant (WTP). Based on the analyses performed in the 2001 ILAW PA (Mann et al. 2001) and repeated in the IDF Risk Assessment (Mann et al. 2003a and Appendix A of the 2003 Annual Summary [Mann 2003b]), there will be an increase in estimated groundwater impacts (by about a factor of three), but the performance objectives are still easily met (the estimated beta/photon drinking water dose being estimated as 0.034 mrem EDE/yr during the first 10,000 years compared to a performance objective of 4 mrem/yr during the first 1,000 years) when only ILAW glass produced by WTP is considered.

## 3. Supplemental ILAW Technologies

ORP is also investigating the possible use of supplemental ILAW technologies (IMAP 2003) to immobilize some of the low-activity waste. Testing and analyses are at a preliminary stage. A risk assessment to support the initial selection of supplemental ILAW technologies was issued (Mann et al. 2003c). Future testing and analyses are being conducted. Milestone M62-08 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology 1989) requires that by January 2005 DOE recommend whether ILAW produced by WTP be supplemented by another process. Milestone 62-11 (due January 2006) requires that DOE and Washington State Department of Ecology (Ecology) agree on a path forward.

## C. PROGRESS IN ILAW PA ACTIVITY SINCE 2001 ILAW PA

In preparation of the 2005 IDF PA, the following data packages have been issued:

- Disposal Facility (*Facility Data For The Hanford Integrated Disposal Facility Performance Assessment* [Puigh 2004a])
- Inventory (*Inventory Data Package For The 2005 Integrated Disposal Facility Performance Assessment* [Puigh et al. 2004b])
- Geology (*Geologic Data Package for the 2005 Integrated Disposal Facility Performance Assessment* [Reidel 2004])

- Recharge (*Recharge Data Package for the Integrated Disposal Facility Performance Assessment* [Fayer and Szecsody 2004])
- Waste Form Release (*Waste Form Release Data Package for the 2005 Integrated Disposal Facility Performance Assessment* [Pierce et al. 2004])
- Hydrology – Near Field (*Near-Field Hydrology Data Package for the 2005 Integrated Disposal Facility Performance Assessment* [Myers 2004])
- Hydrology – Far Field (*Far-Field Hydrology Data Package for the Integrated Disposal Facility* [Khaleel 2004])
- Geochemistry (*Geochemical Data Package for the2005 Hanford Integrated Disposal Facility Performance Assessment (IDF PA)* [Krupka et al. 2004])
- Dosimetry (*Exposure Scenarios and Unit Dose Factors for Hanford Tank Waste Performance Assessment* [Rittmann 2004])

There has been significant progress to the disposal facility concept and design since the creation of the 2001 ILAW PA. This year the final design of IDF was issued (Dehner 2004a and 2004b). The IDF consists of a single landfill with two separate, expandable cells. Cell 1 will be utilized for the disposal of mixed low-level waste (MLLW), including ILAW, and will be permitted under the Resource, Conservation, and Recovery Act (RCRA). Cell 2 will be the disposed site for low-level radioactive waste. Both cells will be regulated under the DOE Order on Radioactive Waste Management (DOE O 435.1).

Because of the change in mission, there are additional sources of inventory to be placed in the disposal facility. As these new sources are mainly an extension of the waste currently being disposed or previously destined to be disposed in Hanford's existing solid waste disposal facilities, projections exist for these waste. The most important new waste stream for long-term impacts analyzed by this performance assessment activity is secondary waste from the production of ILAW. This waste stream is expected to produce greater radiological impacts than from the ILAW (Mann et al. 2003c). In addition, there is a better understanding of the inventory in the large Hanford underground tanks that are the source of most of the inventory in IDF. The estimated inventory of $^{99}$Tc has deceased by 10%, and the inventory of $^{129}$I has decreased by over a factor of 2 (see Section VI. D).

Five additional characterization boreholes have been drilled and sampled around the IDF site since the 2001 PA, based on the comments of the Low-Level Waste Disposal Facility Federal Review Group (LFRG). The data from these holes confirm the conclusions of the 2001 ILAW PA that the geology underneath the IDF site consisted of sand over an open framework gravel, having very high saturated hydraulic conductivities.

Significant decreases in the estimated recharge rates (i.e., the rate at which moisture exits the near surface segment of soil) at the IDF site. These are based on field, laboratory, and computer analyses. The estimated natural recharge rate at the site was decreased from 4.2 mm/year to 0.9 mm/year. In addition, based on an analysis of how soil properties change with time, the recharge rate for the degraded barrier was reduced from the natural rate to lower rates. These changes are expected to greatly reduce the long-term environmental impacts from IDF as groundwater impacts are generally proportional to recharge rates.

The 2001 ILAW PA evaluated a glass composition (LAWABP1) developed by the ILAW PA activity. Data now exist on 3 glasses chosen as reference glasses by the designers/constructors of the Waste Treatment Plant (LAWA44, LAWB45, and LAWAC22) as well as for three glasses containing actual radioactive Hanford tank waste. These data indicate that the estimated glass release rates of the reference glasses will be similar to the estimated rates of the glass composition evaluated in the 2001 ILAW PA.

The waste form data package also contains release parameters for cementious waste forms (waste packages to be used for secondary ILAW and IHLW wastes and for other mixed wastes), a set of data not needed for the 2001 ILAW PA. A separate data package is expected in December 2004 to provide release data for supplemental ILAW waste forms.

Two data packages have been issued for hydraulic properties. One covers the conditions in the disposal facility, while the other covers the vadose zone. There should be no significant differences from the 2001 ILAW PA caused by this new information.

Since the issuance of the 2001 ILAW PA, the understanding of contaminant mobility at the Hanford Site has been expanded by the integrated effort of many Hanford Site risk assessment efforts. The mobility of some contaminants has increased (uranium under high pH conditions), while others have decreased (e.g., iodine). Results from detailed calculation will be included in the 2005 IDF PA.

The dosimetry has expanded to cover many more scenarios, metrics, and contaminants. However, for the scenarios and contaminants of interest to the IDF performance assessment activity, the changed in estimated impacts is small.

In addition to the data packages 26 articles, presentations, and reports have been published since the 2003 Annual Summary. All of this information is covered in the data packages for the 2005 IDF PA.

In summary, these data collection activities confirm the conclusions of the 2001 ILAW PA. They also indicate that environmental risk estimates in the 2005 IDF PA should be lower than those estimated in the *Integrated Disposal Facility Risk Assessment* (Mann et al. 2003a) and the *Risk Assessment Supporting the Decision on the Initial Selection of Supplemental ILAW Technologies* (Mann et al. 2003c).

## D. PATH FORWARD

The IDF PA, which is scheduled to be issued in July 2005, will be the basis for modifying the Hanford Site Disposal Authorization Statement (DAS) to cover the disposal of any other waste (such as supplemental ILAW) into IDF. It is expected that that 2005 IDF PA will contain sufficient information to support the disposal of any supplemental ILAW product or secondary waste that may be selected. Dates for events that are significant to the IDF performance assessment are summarized in Table S-1.

**Table S-1. Current Planning Dates for the IDF (As of October 1, 2004)**

| Date | Event |
|---|---|
| Sept. 2003 | ORP determines which supplemental ILAW technologies will be further investigated (completed) |
| August 2004 | Vegetation clearing begins at IDF (completed) |
| Sept. 2004 | Start of Construction of IDF (completed) |
| Dec. 2004 | Issuance of this document |
| Jan. 2005 | ORP proposes a path forward for fraction of ILAW to be generated by WTP and the fraction to be generated by supplemental processes.* |
| July 2005 | Issuance of IDF Performance Assessment |
| Nov. 2005 | Issue Waste Acceptance Criteria |
| Jan. 2006 | ORP and regulators decide on fraction of ILAW to be produced in WTP.* |
| Jan. 2006 | Any further modification of Hanford Disposal Statement by LFRG/DOE-HQ |
| Mar. 2006 | Start of Operation of IDF |

DOE-HQ = Department of Energy headquarters

IDF = Integrated Disposal Facility

ILAW = immobilized low-activity waste

LFRG = Low-level Waste Facility Federal Review Group

ORP = Office of River Protection

WTP = Waste Treatment Plant

* The Washington State Department of Ecology, the Environmental Protection Agency, and DOE have agreed to propose that these dates be deferred by 18 months.

# I. INTRODUCTION

Reprocessing of irradiated nuclear reactor fuel for the production of special nuclear materials at the Hanford Site in southeastern Washington resulted in a large amount of mixed radioactive/hazardous waste. Presently 53 million gallons of this waste are stored in 177 large underground tanks in the central plateau area of the Hanford Site. The DOE (DOE 1997) plans to

- Retrieve this waste in accordance to the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology 1989),
- Separate the retrieved waste into two streams: a low-activity waste stream (having most of the volume) and a high-level waste stream (having much smaller volume),
- Vitrify each waste stream,
- Store and eventually transport the immobilized high-level waste stream to a federal geologic repository, and
- Store and dispose of the ILAW on the central plateau of the Hanford Site.

Low-level waste associated with these and other activities have been and are being generated at the Hanford Site. Also, the Hanford Site has been selected (DOE 2000) as a disposal site for low-level wastes from other DOE sites. The ROD ("Record of Decision for the Solid Waste Program, Hanford Site, Richland, WA: Storage and Treatment of Low-Level Waste and Mixed Low-Level Waste; Disposal of Low-Level Waste and Mixed Low-Level Waste, and Storage, Processing, and Certification of Transuranic Waste for Shipment to the Waste Isolation Pilot Plant," [DOE 2004a]) for Hanford Site Solid Hazardous and Radioactive Waste Environmental Impact Statement (EIS, DOE 2004b) has determined that the ILAW wastes, Hanford's WTP melters, other Hanford Site solid radioactive waste (including mixed radioactive/hazardous waste) as well as solid radioactive waste generated off-site are to be disposed of in an IDF at the Hanford Site. This ROD does not address ILAW generated external to the WTP.

Previous studies for this disposal site southwest of the PUREX facility in Hanford's 200 East Area (Mann et al. 2001, Mann 2002a) concentrated on the disposal of only ILAW. Other work (Wood et al. 1995, Wood et al. 1996, Wood 2002, and Van Leuven 2003) evaluated solid waste disposed of elsewhere on the Hanford Site. A risk assessment (Mann et al. 2003a, also Appendix A of the 2003 Annual Summary [Mann 2003b]) has been issued to evaluate the performance of the proposed IDF as defined in the Hanford Solid Waste Environmental Impact Statement. Construction began in September 2004. The IDF is scheduled to start receiving wastes in 2006. This latter date is subject to receiving the necessary approvals (e.g., Atomic Energy Act and Resource, Conservation, and Recovery Act) by DOE/HQ and the State of Washington.

In accordance with the DOE order on radioactive waste management (DOE O 435.1 – DOE 1999a), DOE/HQ must approve a PA and issue a DAS before construction can begin on the low-level waste disposal facility. A PA is an evaluation of long-term public health and the environmental impacts from the disposal action, resulting in a comparison of the estimated impacts with standards to determine whether the disposal action has a “reasonable expectation” of meeting those standards. The *Hanford Immobilized Low-Activity Tank Waste Performance Assessment* (Mann et al. 1998) was conditionally approved in 1999 and a DAS was issued. The DAS requirements to issue a PA maintenance plan and have it approved by the Field Office Manager were met in 2000 (Mann 2000). As required by the DOE order on radioactive waste management (DOE O 435.1) and the *Maintenance Plan for the Hanford Immobilized Low-Activity Tank Waste Performance* Assessment, the first annual summary of the ILAW PA was issued in 2000 (Mann 2000).

However, because of significant changes in waste form and in disposal facility design as well as new information about the proposed disposal site, a new performance assessment, *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version* was created. The draft was sent to DOE/HQs on April 3, 2001 for review and approval. Based on recommendations of the Low-Level Waste Disposal Facility Federal Review Group, the DOE approved the PA and issued a revised DAS (DOE 2001).

Because the next ILAW PA is scheduled to be sent to the DOE in July 2005, the DOE order on radioactive waste management requires that an annual summary be prepared. Annual summaries were also issued in 2002 (Mann 2002a) and 2003 (Mann 2003b). Based on the review by the LFRG of the 2003 Annual Summary, DOE/HQ determined (DOE 2003c) that the Hanford Site DAS remains in effect recognizing the change of waste destined for the disposal facility.

The format for this annual summary follows that required by the maintenance plan (as directed by the DOE guidance on PA maintenance plans [DOE 1999b]) with the exceptions of the inclusion of this introduction and the next section which provide program developments since the issuance of the 2003 ILAW PA Annual Summary (Mann 2003b).

# II. PROGRAM DEVELOPMENTS

There have been several program developments that affect the Integrated Disposal Facility during the past year. There also has been significant progress to the disposal facility concept and design

## A. MANAGEMENT ISSUES

There are two management activities that impact this activity. Both involve the basic mission of the disposal facility.

- DOE decided that all low-level radioactive waste, including mixed radioactive/hazardous waste [other than that generated under the Comprehensive Environmental Reporting, Liability, and Compensation Act (CERCLA)] to be disposed of after 2006 at the Hanford Site will be disposed of at the ILAW Site. Such waste includes traditional solid low-level radioactive waste, solid mixed radioactive/hazardous waste, as well as melters from Hanford's Waste Treatment Plant. Solid waste from other DOE sites will also be disposed.
- An additional (potential) issue is whether all of the ILAW will be glass produced in the Hanford Waste Treatment Plant (WTP) or whether, the WTP production of ILAW will be supplemented by production of a different waste form at a different facility. In October 2003, DOE's Office of River Protection (ORP), the Washington Department of Ecology, and the U.S. Protection Agency agreed to further study supplemental ILAW waste forms. In January 2005, Milestone 62-08 of the Hanford Federal Facility Agreement and Consent Order (Ecology 1989) requires that the ORP Field Manager recommend how ILAW will be produced. Milestone 62-11 requires that DOE, Ecology, and EPA agree by January 2006 on the baseline for producing ILAW.

The *Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement Richland, Washington* (DOE 2004b) analyzed various disposal options for radioactive waste and mixed Resource, Conservation, and Recovery Act (RCRA) hazardous radioactive waste at the Hanford Site. The ROD (DOE 2004a) documents the decision that one integrated facility should be built at the site that has been proposed as the ILAW Disposal Facility.

The effect of the ROD is to increase the scope of this performance assessment effort from just ILAW disposal (which is a mixed radioactive/hazardous waste) to all of the waste to be disposed of at the IDF. The 2005 update to the ILAW performance assessment will address the revised scope. The second effect of the ROD is to cause a slight change in the design of the disposal facility, mainly a little deeper with 2 cells replacing the previous six trenches.

The DOE Manager of the ORP decided (Schepens 2003) that a separate Tc separations process in the WTP was not justified based on cost, efficiency, and environmental impacts. This has the impact of increasing the amount of $^{99}$Tc to be disposed of as ILAW WTP glass. As shown in the 2001 ILAW PA (Mann et al. 2001), the lack of Tc separations would cut the 2001 ILAW PA base case margin of at least 300 by a factor of three. This was discussed in last year's annual summary (Mann 2003b).

The ORP and the Tank Farm Contractor (TFC: currently CH2M Hill Hanford Group, Inc.) are investigating whether there are supplemental treatments of low-activity waste that could reduce costs and time durations of treating low-activity tank wastes, yet would protect the environment. With the cooperation of the Washington State Department of Ecology and the U.S. Environmental Protection Agency, three candidate waste treatment waste processes (bulk vitrification, solidification in CastStone [a cementious waste form], steam reforming) were found to deserve further investigation. In October 2003, the cementious waste form was eliminated for consideration as a primary waste form for ILAW. Under a program separate from, but coordinated with, the IDF PA activity, the TFC has continued performing tests on bulk vitrification (See section V.D.6). DOE has continued a limited program on the steam reforming process.

## B. PROGRAM PROGRESS

The 2001 ILAW PA was based upon the Project W-520 concept of six lined trenches at the ILAW disposal site, which is located in Hanford's 200 East Area southwest of the PUREX facility. In September of 2002, an Alternative Generation Analysis (AGA) (Aromi 2002) was performed to evaluate alternatives at the disposal of ILAW, mixed low-level waste (MLLW) and low-level waste (LLW) on the Hanford site. The authors concluded that development of an Integrated Disposal Facility (IDF) is superior (financially and environmentally) to current and previously planned Hanford Site disposal facilities. The IDF would be expandable as additional space is needed on the ILAW site.

The *Hanford Site Solid (Radioactive and Hazardous) Waste Program Environmental Impact Statement Richland, Washington* (DOE 2004b) has been completed with a Record of Decision (ROD) issued (DOE 2004a). The ROD concluded the IDF located in the 200 East Area (same as the ILAW site) would be the disposal path for ILAW, LLW and MLLW. The schedule for the IDF has been accelerated from the vitrification plant need date of 2011 to 2006 to provide adequate space for LLW and MLLW generated from on-site and potential off-cite activities.

Key Program accomplishments are

- The Part B Permit application for the IDF was submitted in June 2003 (DOE 2003b), based upon the new IDF concept. In order to submit the permit application, an 80 percent complete detailed design of the critical systems for the IDF was completed and included in the Part B Permit. The design provided for expansion of the IDF as necessary. The IDF design includes separate cells for hazardous and non-hazardous waste. A permitting plan (Wooley 2004) was also created.
- Three 15-meter bore holes were drilled and sampled on the IDF site in FY 2003 to support the IDF design and the Pre-Operation Monitoring Plan (Horton et al. 2000) for the site.
- A new Level 1 Specification and Project Design Criteria (Kruger 2004a/b) for ILAW, MLLW, LLW, and WTP melters was prepared and approved.

- To support the IDF concept, a risk assessment for the IDF (Mann 2003a) was performed in FY 2003 to determine if there were increased environmental impacts due to the IDF concept. This risk assessment analyzed the impacts from the disposal of ILAW glass produced by the WTP, Hanford LLW (including mixed radioactive-hazardous wastes) not regulated by CERCLA, off-site low-level waste (including mixed radioactive-hazardous wastes), as well as the WTP melters. The performance objectives were easily met (see the discussion in Section VI.A.2.b).
- A hazards operability evaluation (Sandgreen and Shultz 2004) was completed.
- The detailed design (Dehner 2004a/b ) and start of construction was completed in FY 2004. Other associated design documentation has also been produced (Dehner 2004 c/d/e).

As of January 2005, the IDF construction has been placed on hold pending resolution of the Part B permit application. The resolution is expected to complete in FY 2005, in time to restart construction and to meet the FY 2006 disposal needs.

The waste acceptance criteria will be updated in FY 2005 time period to reflect 1) the additional wastes for disposal in the IDF and 2) consistency with the FY 2005 PA results.

As previously explained, a supplemental technology may be selected to treat a portion of the low-level tank waste for disposal in the IDF. Should this occur, the new waste form will be evaluated for disposal and updates to performance assessments and waste acceptance criteria will be made.

The IDF PA, scheduled to be issued in July 2005, will be the basis for modifying the DAS to allow the disposal of any other waste (such as supplemental ILAW) into the IDF. It is expected that the 2005 IDF PA will contain sufficient information for any supplemental ILAW technology that might be selected. These events are summarized in the Table 1 below.

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DOE-HQ = Department of Energy headquarters

IDF = Integrated Disposal Facility

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* The Washington State Department of Ecology, the Environmental Protection Agency, and DOE have agreed to propose that these dates be deferred by 18 months.

# III. WASTE RECEIPTS

There have been no waste receipts, as the disposal facility has not begun operation. The expected inventory to be disposed of in IDF is given in *Inventory Data Package for the 2005 Integrated Disposal Facility Performance Assessment* (Puigh et al 2004b).

# IV. MONITORING

A pre-operational monitoring plan (Horton 2000) has been issued and approved (Boston 2000). It calls for drilling groundwater monitoring wells and subsequent monitoring per the requirements of the RCRA. A revision is underway and should be issued by the end of December 2004. The plan also calls for monitoring of air resources and the identification of any vadose zone contamination. Additional boreholes have been drilled, and they verify the lack of subsurface contamination from adjacent facilities. The pre-operational monitoring plan is now being implemented. Six of the eight groundwater wells for IDF have been completed. The remaining two wells will be completed this fiscal year.

The Hanford Site has a groundwater-monitoring program, with the results for FY 2003 just released (Hartman et al. 2004). Previous discharges from Hanford Site operations, primarily liquid discharges to cribs associated with the PUREX plant, have impacted groundwater underneath the proposed disposal facility. Although these cribs are currently down gradient from the proposed disposal site, the plumes from these cribs hydraulically spread up gradient to underneath the proposed disposal site due to hydraulic pressures caused by the large volumes of liquids disposed in the cribs. The level of groundwater contamination for tritium is above drinking water standards (20,000 pCi/liter) in part of the proposed disposal site. However, given the short half-life of tritium and the long vadose zone travel time for ILAW contaminants, any tritium will have decayed by the time that ILAW contaminants reach groundwater. Groundwater contamination levels from other contaminants of concern (mainly $^{129}$I and nitrate) were found to be below drinking water standards.

Hanford Site records indicate no significant operational activities have been performed at the proposed disposal site. Thus, no vadose zone contamination is expected. Part of the ILAW PA borehole task was to search for contamination in the vadose zone from near-by cribs. No vadose zone contamination (only naturally occurring radioactivity) has been found in the any of the six boreholes drilled, all of which have gone to at least 25 feet below the water table.

# V. RESEARCH AND DEVELOPMENT

## A. SUMMARY

Research and Development (R&D) of significance to the IDF PA is conducted in several programs. The IDF PA activity directly funds selected R&D as documented in the last update of its statement of work (Puigh and Mann 2002). The IDF PA activity also maintains contact with the WTP, particularly in the areas of waste form composition and inventory. The IDF PA tightly coordinates its activity with the Tank Farm Vadose Zone Project, as both investigate vadose zone properties for Hanford's Tank Farm Contractor (TFC, currently CH2M Hill Hanford Group, Inc.). The IDF PA, the Tank Closure PA, and the Hanford Site-wide Assessment activities share data and methods. The last activity is responsible for the Hanford Site Composite Analysis. The IDF PA activity is also associated with the Hanford Groundwater / Vadose Zone Integration Project, now called the Groundwater Remediation Project. As one of the "core projects" of the Hanford Groundwater / Vadose Zone Integration Project, the IDF PA activity maintains close contacts with the Integration Project's Science and Technology and System Assessment Capability activities as well as with DOE's science and technology activities and the Office of Science's Environmental Management Science Program (EMSP]). The IDF PA also receives data from Hanford's Remediation and Closure Science Project, another core project. All of these programs provide data and information that are directly utilized in developing a more complete understanding of the mechanisms that impact the IDF disposal facility system performance. Finally, the IDF PA activity is part of the effort by the Tank Farm Contractor's ILAW Treatment Project, which is managing the Demonstration Bulk Vitrification System, including its research and development efforts.

## B. DAS-DIRECTED R&D

No R&D activities were directly required by the facility's disposal authorization statement (DOE 2001). However, the cover letter for the DAS (DOE 2001) states, "However the LFRG [Low-Level Waste Disposal Facility Federal Review Group] review emphasized the importance of the glass waste form consistency in meeting your performance criteria established in the performance assessment. As a result of the need for short and long-term waste form integrity it is imperative that appropriate and sufficient glass testing, including product consistency tests, be carried out prior to disposal to confirm that the assumptions used in the performance assessment are representative of the final waste form." Waste Form testing is an important part of the IDF PA activity and is described in the next section.

## C. IDF PA R&D

The IDF PA activity has sponsored many research and development activities. A list of papers and reports is presented in Table 2. Table 3 summarizes the IDF PA R&D activities by functions and provides the overall impacts the findings from these activities have on the performance assessment.

**Table 2. Papers by IDF PA Activity from July 2003 to September 2004(3 Pages)**

| |
|---|
| D.H. Bacon, MI Ojovan, BP McGrail, NV Ojovan, and IV Startsceva. 2003. "Vitrified waste corrosion rates from field experiment and reactive transport modeling." In proceedings of *ICEM'03, 9th International Conference on Radioactive Waste Management and Environmental Remediation*, Oxford, England. |
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| K.M. Krupka, R.J. Serne, and D.L. Kaplan. 2003, *Geochemical Data Package for the2005 Hanford Integrated Disposal Facility Performance Assessment (IDF PA)*, PNNL-13037, Rev. 2, Pacific Northwest National Laboratory, September 2004 |
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| F.M. Mann, B.P. McGrail, D.H. Bacon, R.J. Serne, K.M. Krupka, R.J. Puigh, R. Khaleel, and S. Finfrock. 2003. *Risk Assessment Supporting the Decision on the Initial Selection of Supplemental ILAW Technologies*. RPP-17675, CH2M HILL Hanford Group, Inc., Richland, Washington. |
| S. V. Mattigod, G. Fryxell, R. Serne, and K. E. Parker, 2003, "Evaluation of Novel Getters for Adsorption of Radioiodine from Groundwater and Waste Glass Leachates," *Radiochimica Acta,* 91(9):539 |

**Table 2. Papers by IDF PA Activity from July 2003 to September 2004(3 Pages)**

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|---|
| S.V. Mattigod, R.J. Serne, V.L. LeGore, K.E. Parker, R.D. Orr, D.E. McCready, and J.S. Young. 2003b. *Radionuclide Incorporation in Secondary Crystalline Minerals Resulting from Chemical Weathering of Selected Waste Glasses: Progress Report: Task kd.5b*. PNNL-14391, Pacific Northwest National Laboratory, Richland, Washington. |
| S. V. Mattigod, G. Fryxell, R. J. Serne, B. P. McGrail, V. L. LeGore, and K.E. Parker 2004, "Sequestration "Evaluation of Radionuclides ($^{125}$I, $^{75}$Se, $^{99}$Tc) in Secondary Crystalline Minerals Resulting in Novel Getters for Adsorption of Radioiodine from Chemical Weathering of Groundwater and Waste Glasses" to be submitted to *Radiochimica Acta* in fall of 2004, 91(9):539 |
| B.P. McGrail, D. H. Bacon, R. J. Serne, and E. M. Pierce. 2003. *A Strategy to Assess Performance of Selected Low-Activity Waste Forms in an Integrated Disposal Facility*. PNNL-14362, Pacific Northwest National Laboratory, Richland, Washington. |
| P.D. Meyer, K.P. Saripalli, and V.L. Freedman. 2004. *Near-Field Hydrology Data Package for the Integrated Disposal Facility 2005 Performance Assessment*. PNNL-14700, Pacific Northwest National Laboratory, Richland, Washington.. |
| K. E. Parker, M. J. Lindberg. 2004. "Conservative Solute Transport through Stony Saturated Media." Submitted for publication to *Advances in Water Resources*. |
| E.M. Pierce, B.P. McGrail, E.A. Rodriguez, H.T. Schaef, K.P. Saripalli, R.J. Serne, K.M. Krupka, P.F. Martin, S.R. Baum, K.N. Geiszler, L.R. Reed, and W.J. Shaw , 2004. *Waste Form Release Data Package for the 2005 Integrated Disposal Facility Performance Assessment*. PNNL-14085, Pacific Northwest National Laboratory, Richland, Washington |
| C. Pluhar. 2003, "Cosmogeneic Burial Dating and Magnetostratigraphy of Early and Mid-Pleistocene Missouri Flood Sediments, Hanford, Washington," Geological Society of America abstracts associated with program 86-12. |
| R.J. Puigh. 2004. *Facility Data for the Hanford Integrated Disposal Facility Performance Assessment*. RPP-20691 |
| R.J. Puigh, M.I. Wood, and D.W. Wootan. 2004. *Inventory Data Package for the 2005 Integrated Disposal Facility Performance Assessment*. RPP-20692, Rev. 0, Fluor Federal Services, Inc., Richland, Washington. |
| S.P. Reidel. 2004. *Geologic Data Package for 2005 Integrated Disposal Facility Waste Performance Assessment*. PNNL-14586, Pacific Northwest National Laboratory, Richland, Washington |

**Table 2. Papers by IDF PA Activity from July 2003 to September 2004(3 Pages)**

| |
|---|
| K.P. Saripalli, V.L. Freedman, P.D. Meyer and B.P. McGrail. 2003. Characterization of the Specific Solid-Water Interfacial Area-Water Saturation Relationship and its Import to Reactive Transport in Unsaturated Porous Media," in preparation for submittal to *Vadose Zone J*. |
| K.P. Saripalli, P.D. Meyer, K. E. Parker, and M. J. Lindberg. 2004a. "Effect of Chemical Reactions on the Hydrologic Properties of Fractured and Rubbleized Glass Media," Accepted for publication in *Applied Geochemistry*... |
| K. P. Saripalli, M. J. Lindberg, and P. D. Meyer. 2004b. "Conservative Solute Transport through Stony Saturated Media." Submitted for publication to *Advances in Water Resources*. |
| D. A. Shaughnessy, H. Nitsche, C. H. Booth, D. K. Shuh , G. A. Waychunas, R. E. Wilson, H . Gill, K. J. Cantrell, and R. J. Serne. 2003. "Molecular Interfacial Reactions between Pu(VI) and Manganese Oxide Minerals Manganite and Hausmannite." *Environ. Sci. Technol*. 37:3367 |
| W. Um, and R.J. Serne. 2004a. "Sorption and Transport Behavior of Radionuclides in the Proposed Low |
| W. Um, R.J. Serne, and K.M. Krupka. 2004b. "Linearity and reversibility of iodide adsorption on sediments from Hanford, Washington under water saturated conditions." *Water Res.* 38:2009-2016. |

The next performance assessment is planned to be sent to DOE/HQ in July 2005. Therefore, R&D efforts for that document are completed. The data packages to be used in the 2005 IDF PA have been issued:

- Disposal Facility (*Facility Data For The Hanford Integrated Disposal Facility Performance Assessment* [Puigh 2004a])
- Inventory (*Inventory Data Package For The 2005 Integrated Disposal Facility Performance Assessment* [Puigh et al. 2004b])
- Geology (*Geologic Data Package for the 2005 Integrated Disposal Facility Performance Assessment* [Reidel 2004])
- Recharge (*Recharge Data Package for the Integrated Disposal Facility Performance Assessment* [Fayer and Szcesody 2004])
- Waste Form Release (*Waste Form Release Data Package for the 2005 Integrated Disposal Facility Performance Assessment* [Pierce et al. 2004])
- Hydrology – Near (*Near-Field Hydrology Data Package for the 2005 Integrated Disposal Facility Performance Assessment* [Myers et al. 2004])
- Hydrology – Far (*Far-Field Hydrology Data Package for the Integrated Disposal Facility* [Khaleel 2004])

- Geochemistry (*Geochemical Data Package for the2005 Hanford Integrated Disposal Facility Performance Assessment (IDF PA)* [Krupka et al. 2004])
- Dosimetry (*Exposure Scenarios and Unit Dose Factors for Hanford Tank Waste Performance Assessment* [Rittmann 2004])

## D. OTHER R&D

A variety of research and development activities are underway, and there is close cooperation among many of those activities. Important ties are with the Environmental Management Science Program (EMSP) (glass performance and other activities), the Tank Farm Vadose Zone Project (TFVZP) (vadose zone characterization, particularly under highly contaminated conditions), the Environmental and Closure Science Project of the Groundwater Protection Project (various efforts), the Waste Treatment Plant, and the Bulk Vitrification Demonstration System.

### 1. Environmental Management Science Program

The EMSP has supported important research into glass performance. At higher temperatures, the breaking of silicon bridging bonds is the rate-determining step. At temperatures corresponding to soil conditions and with high sodium content glasses, a second reaction (the ion exchange of hydrogen and sodium) becomes significant (McGrail et al. 2000). The EMSP activity in this area has provided important data and understanding of how this formerly overlooked reaction proceeds.

Based on borehole data for the proposed disposal site and the fact that the site is uncontaminated, several EMSP tasks are using the disposal site for field experiments. Moreover, at the kick-off meeting for principal investigators of FY 1999 EMSP subsurface awards, details of the proposed ILAW disposal site were described and many contacts established. Such contacts have been maintained through annual meetings and other means. In particular, the ground penetrating radar task supported by EMSP was coordinated with ILAW-specific work to better characterize the proposed disposal site as well as other Hanford Central Plateau sites that will be used by the Science and Technology activity of the Hanford Groundwater / Vadose Zone Integration Project for research and development activities.

### 2. Tank Farm Vadose Zone Project

The TFVZP operates another large characterization project for the ORP. This activity is doing extensive vadose zone characterization of the Hanford Site tank farms. The *Field Investigation Report for Waste Management Area B-BX-BY* (Knepp 2002a) and *Field Investigation Report for Waste Management Area S-SX* (Knepp 2002b) describes the effort for the first two sets of tank farms being investigated. The leader of the IDF PA activity and many of the scientific staff are working on both the IDF PA and TFVZP efforts.

**Table 3. IDF PA Research &Development Activities**
**(Most efforts are designed to confirm laboratory results or yet to be made management decisions)**

| Activity | Uncertainty or Question Being Addressed | Expected Completion [a] | Potential or actual impact of results on performance objectives and adequacy of current PA |
|---|---|---|---|
| Waste Form | | | |
| Primary Released Rate | Rate at which contaminants are released from waste form | 2015 PA | Laboratory measurements indicate envelope A glass (most of the glass) is superior to that considered in 2001 PA. Performance of other envelopes is comparable to the LAWABP1 glass analyzed in 2001 PA. Processes modeled in 2001 PA have been shown to be dominant. |
| Secondary Phases | Rate at which key contaminants (e.g. Tc) may be trapped in secondary phases of waste form | 2010 PA | Short-term experiments indicate a reduction of 50% in the impacts of 2001 PA. 2001 PA is bounding. |
| Field Verification | Reliability of laboratory testing in predicting field conditions | 2020 PA | Glass has just been placed in field in 2003. Measurements show no leaching. |
| Supplemental ILAW waste forms | Rate at which contaminants are released from waste form | 2010 PA [b] | Approved 2001 PA does not cover these waste forms. The waste form is being considered to supplement WTP ILAW glass production. |
| Grouted waste forms | Rate at which contaminants are released from waste form | 2015 PA | Approved 2001 PA does not cover these waste forms. Solid waste has been added to the scope per the Record of Decision for the Solid Waste Program, Hanford Site, Richland, WA (DOE 2004a). |

**Table 3. IDF PA Research &Development Activities**
**(Most efforts are designed to confirm laboratory results or yet to be made management decisions)**

| Activity | Uncertainty or Question Being Addressed | Expected Completion (a) | Potential or actual impact of results on performance objectives and adequacy of current PA |
|---|---|---|---|
| Inventory | Inventory actually disposed in facility | Closure PA | Tank waste: The inventory for $^{99}$Tc disposed in the IDF (most important contaminant in 2001 ILAW PA) is about 4 times higher than used in 2001 PA (due primarily to removal of Tc separations). The inventory for $^{129}$I disposed in the IDF is approximately 45% higher than used in the 2001 PA (due primarily to inclusion of secondary WTP waste streams into the IDF and a lowering of the estimated I-129 inventory in the tanks).<br>Other Hanford Site solid waste: new source of waste<br>Off-site waste: new source of waste. |
| Geology | Adequacy in understanding different layers and adequacy of groundwater channel | 2005 PA | Additional boreholes have confirmed information in 2001 PA |
| Hydrology – Near - Field | Moisture content adjacent to waste forms | 2005 PA | Preliminary calculations indicate increased moisture content near glass, increasing release rate several fold for same recharge. |
| Hydrology – Far Field | Adequacy in understanding moisture flow in vadose zone | 2005 PA | Up-scaling and lateral flow assumptions in 2001 PA seem adequate |

**Table 3. IDF PA Research &Development Activities**
**(Most efforts are designed to confirm laboratory results or yet to be made management decisions)**

| Activity | Uncertainty or Question Being Addressed | Expected Completion [(a)] | Potential or actual impact of results on performance objectives and adequacy of current PA |
|---|---|---|---|
| Geochemistry | Adequacy in understanding contaminant transport | 2005 PA | Transport of $^{99}$Tc (the most important contaminant in the 2001 ILAW PA) has not changed. Transport of $^{129}$I (one of 2 major contaminants in the 2001 PA) is now considered slightly retarded, reducing impacts. The transport of uranium (considered slightly retarded in the 2001 ILAW PA) is now seen at the same rate of $^{129}$I (potentially increasing some impacts). |
| Recharge | Amount of moisture entering the disposal facility and forcing contaminants to groundwater | 2015 PA | Best estimates of natural recharge are now lower than in 2001 ILAW PA. The long-term recharge through the degraded surface barrier is thought to be very much lower. These effects will greatly decrease impacts. |
| Dosimetry | Conversion between groundwater concentrations and exposure | 2010 PA | ORP, RL, EPA, and Washington State Department of Ecology discussing alternatives, relative to tank closure. 2001 PA should be limiting. |

(a) Assumes no new data or information becomes available which contradicts PA.
(b) First full analysis. Depending on availability of information, more time may be required.

| | | | |
|---|---|---|---|
| IDF PA = | Integrated Disposal Facility Performance Assessment | R&D = | research and development |
| ORP = | Office of River Protection | HQ = | Department of Energy Headquarters |
| RL = | Richland Operations | EPA = | Environmental Protection Agency |

## 3. Integration Project's Environmental and Closure Science Project

The major projects at the Hanford Site that analyze environmental impacts have joined together to form the Hanford Groundwater Remediation Project (better known as the Integration Project, which is taken from the project's original name, the Hanford Groundwater / Vadose Zone Integration Project). Various contractors manage these projects, one of which is the IDF PA activity. However, the projects coordinate their activities so that information generated by one activity can be used by all and activities can be modified for the common benefit of the site.

A major part of the Integration Project's effort is the Environmental and Closure Science Project (formerly the Science and Technology activity). This project supports tasks that supplement on-going Hanford Site characterization efforts ("wrap-around science"), that investigate near-surface vadose zone flow, and that gather data on ecological impacts. The most supportive work for the ILAW PA has been the wrap-around-science tasks associated with the Tank Farm Vadose Zone Project. Such tasks have provided a much better understanding of contaminant transport in high sodium environments. The investigations of near-surface vadose zone flow have provided information on various remote sensing monitors.

## 4. Integration Project's Waste Site Remediation Project

Another major part of the Integration Project is the effort to remediate soils and structures (other than tank farms) located in Hanford's Central Plateau. As part of this effort, characterization efforts began on the BC Cribs and Trenches (which are located just south of the IDF site). These cribs and trenches received untreated tank waste. Through borehole and cone penetrometer soil samples and through surface high resolution resistivity measurements, a better understanding of flow and transport in Hanford's 200 West Area is being achieved.

## 5. Hanford Site-wide Assessment

The Pacific Northwest National Laboratory is developing an integrated system of computer models and databases to assess the cumulative impact of Hanford on human health, ecological, economic, and cultural systems. This system, called the System Assessment Capability (SAC), will be used to create the Hanford Site Composite Analysis in 2005. Assessments performed with the tool consider radiological and chemical wastes remaining, migrating, or being released from the Hanford Site and the effects of clean up decisions being made with respect to these wastes.

An initial assessment performed with the SAC examined the impacts resulting from contaminants remaining on the site after execution of the Hanford Site Disposition Baseline (Bryce et al. 2002), the collection of disposal and remedial actions identified in the Tri-Party Agreement that are planned to occur as Hanford moves toward closure. The capability will now be used to estimate the impacts resulting from alternative cleanup approaches.

## 6. Waste Treatment Plant

The Waste Treatment Plant is determining the glass compositions that will be produced during the initial operations of the plant. The IDF PA is using these compositions in its analyses. In addition, the Waste Treatment Plant is sponsoring seismic research at the IDF site to address questions by the Defense Nuclear Facility Safety Board.

### 7. Bulk Vitrification Demonstration System

The Tank Farm Contractor is planning to treat some of the low-curie waste presently stored in the underground S-109 tank using a bulk vitrification process. In this process, dry tank waste is mixed with soil and then heated using in-situ electrodes to form a glass. The entire container would then be disposed of at IDF. In preparation of this demonstration project, many research and development activities have been conducted to maximize the amount of contamination capture in the glass and minimize the amount otherwise trapped in the container and discharged in the off-gas. Members of the IDF PA team play active roles in the planning and analyses of the experiments and tests.

## E. PLANNED ILAW PA R&D

The amount of R&D effort will be reduced in areas not directly supporting waste form performance. As requested by the Low-Level Waste Disposal Facility Federal Review Group, waste form testing will be an important part of the maintenance effort in FY 2005 and beyond. Emphasis will remain on testing the basic modeling approach to evaluate long-term waste form performance. Efforts will concentrate on WTP glass, bulk vitrification as a supplemental ILAW product, and on cementious waste form used for the secondary wastes generated from ILAW production.

Major new efforts are underway to understand the inventory presently contained in Hanford's large underground tanks. A major update in the Best Basis Inventory (the Hanford Site's official data base for tank waste inventory) occurred during the summer of the 2004. These new data, combined with improved wash factors, and modeling of the Waste Treatment Plant flow sheets using the HTWOS model will be used in early 2005 to update the inventory data package for the 2005 IDF PA (Puigh et al. 2004b).

Long-term measurements (recharge rate measurements and field glass tests, both at the Field Lysimetry Test Facility) are expected to continue.

## F. R&D NEEDS

In 2003, the major "core projects" of the Hanford Integration Project have prioritized science and technology needs. The major needs identified were

- Development and determination of long-term performance of surface barriers (Hanford Site Need RL-WT-017)
- Development of remote sensing of contaminants ($^{99}$Tc, nitrates, uranium) in the subsurface (Hanford Site Need RL-WT-102),
- Development and testing of materials that will chemically bind contaminants (Hanford Site Need RL-WT-061),
- Improved understanding of long-term recharge rates (Hanford Site Need RL-WT-044-S), and
- Improved understanding of moisture movement under arid conditions (Hanford Site Need RL-WT-035-S).

Interestingly, the first three of these are also major needs identified by a recent National Research Council panel on subsurface research needs (NRC 2000).

At the same time, the ILAW PA activity also identified needs focused on the needs of the PA (Gauglitz et al. 2002): They are

- Determination of compositional dependence of the long-term performance of glass as a waste form (Hanford Site Need RL-WT-066)
- Determination of the change in glass surface area as a function of time (Hanford Site Need RL-WT-016), and
- Standardization of methods for determining long-term waste form release rate (Hanford Site Need RL-WT-015).

The efforts supporting the 2005 IDF PA will refine what needs are most significant and which have been adequately addressed.

# VI. SUMMARY OF CHANGES

As noted in Chapter II, there have been major programmatic changes in this activity since the last ILAW PA Annual Summary:

- decision from the Hanford Solid Waste Environmental Impact Statement Record of Decision to create one integrated disposal site at Hanford at the former ILAW site (discussed in Section A.2)
- The potential of immobilizing low-activity waste using different processes than vitrification at the Waste Treatment Plant (discussed in Section A.3). The decision whether to produce such waste forms will not be made until 2006.

With the publication of the data packages for the 2005 IDF PA, the values for some key data have also changed from the values used in the 2001 ILAW PA (Mann et al. 2001).

The following sections summarize the major changes, their impacts on the conclusions of the 2001 ILAW PA, and their likely consequences for the results of the 2005 IDF PA.

A. Change of Mission

B. Performance Objectives

C. Disposal Facility Design

D. Inventory

E. Recharge

F. Geology

G. Hydrology

H. Geochemistry

I. Waste Form Release

J. Groundwater flow

K. Dosimetry

The values that will be used in the base analysis case of the 2005 IDF performance assessment will be determined by the Hanford Configuration Management Board, which was established in November 2004.

The overall system perform is discussed in the next chapter (“VII. Conclusions”).

## A. CHANGE OF MISSION

### 1. Overview

As discussed in Section II.A, two mission evolutions have transformed the mission of what was formerly called the Immobilized Low-Activity Waste (ILAW) Disposal Facility into the Integrated Disposal Facility (IDF). The first is the inclusion of solid waste other than immobilized low-level waste. The second (potentially) is the inclusion of ILAW that is not produced by the Waste Treatment Plant melters.

### 2. Transformation from ILAW DF to IDF

#### a. Introduction.

The "Record of Decision for the Solid Waste Program, Hanford Site, Richland, WA: Storage and Treatment of Low-Level Waste and Mixed Low-Level Waste; Disposal of Low-Level Waste and Mixed Low-Level Waste, and Storage, Processing, and Certification of Transuranic Waste for Shipment to the Waste Isolation Pilot Plant" (DOE 2004a) transformed the ILAW Disposal Facility into the IDF.

The candidate low-level waste that may be disposed of at the IDF can be classified into four (4) categories:

- **Low-level waste (LLW) -** waste that contains man-made radionuclides but which is not classified as high-level waste or transuranic waste, and not otherwise regulated under RCRA or the dangerous waste management laws of Washington. This waste could have been generated on the Hanford Site or could have been imported from offsite. Category 1 (unstabilized) waste has the lowest level of radionuclides. Category 3 (stabilized) waste has higher concentrations and/or amounts and is grouted before disposal.
- **Mixed low-level waste (MLLW)** - waste that contains man-made radionuclides but which is not classified as high-level waste or transuranic waste and which contains materials that are regulated under RCRA or the corresponding dangerous waste management laws of the State of Washington. All mixed waste is considered as Category 3 waste.
- **Immobilized Low-Activity Waste (ILAW)** - Hanford tank waste that has undergone separations treatment to remove most of the radionuclides and then solidified at the Hanford Waste Treatment and Immobilization Plant (WTP). Presently, the only DOE-approved solidification process is WTP vitrification.
- **Failed or Decommissioned Melters** - High-level and low-activity waste melters used to treat tank waste in the WTP.

The disposal of low-level and mixed low level waste had been scheduled for the Hanford Solid Waste Burial Grounds. Such disposal is covered by the *Performance Assessment for the Disposal of Low-Level Waste in the 200 West Area Burial Grounds* (Wood et al. 1995a) and by The *Performance Assessment for the Disposal of Low-Level Waste in the 200 East Area Waste Burial Grounds* (Wood et al. 1996). These performance assessments were approved by DOE

(Cowan 1996 and Frei 1997, respectively). A maintenance plans for these solid waste burial ground performance assessments (Wood et al. 1995a and Wood et al. 1996) has been written. Annual summaries also have been submitted to the LFRG, the latest in 2003 (Wood 2003). In addition, to satisfy the conditional requirements specified in the disposal authorization statement, a review of solid waste characterization practices has been completed and accepted by the LFRG. The review was conducted to determine whether these practices were adequate to support the evaluation of disposal facility performance relative to compliance with performance objectives. Waste characterization practices were found to be adequate and a report was issued to DOE Headquarters in June 2000.

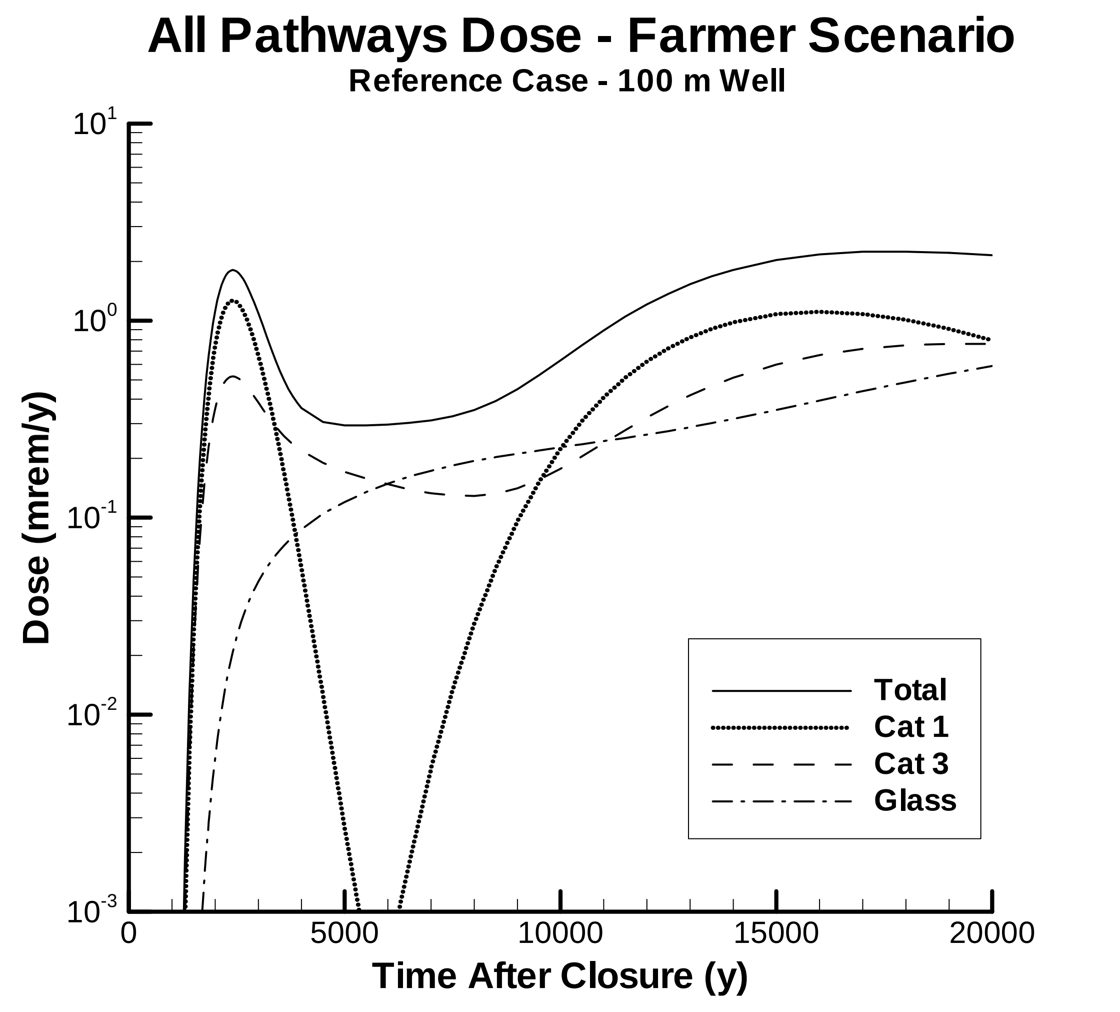
**b. Groundwater impacts.**

In anticipation of the decision to have an integrated disposal facility, the *Integrated Disposal Facility Risk Assessment* (Mann et al. 2003a) was written. This document was summarized in the 2003 ILAW PA Annual Summary and attached to that annual summary. The groundwater impacts of the three main categories of waste (Category 1 solid waste, Category 3 solid waste, and ILAW glass) have different temporal distributions, as seen from Figure 1. The impacts from Category 1 wastes, which have quick releases, peak early (at ~2,400 years after facility closure for contaminants with $K_d$ = 0 mL/g [such as $^{99}$Tc]) and are insignificant after a few more thousand years for those contaminants. However, slightly retarded contaminants from Category 1 wastes, such as uranium, become important at latter times, reaching a level comparable to Category 3 and ILAW wastes. The impacts from Category 3, which are encased in grout, peak a bit later than the mobile contaminants from Category 1 wastes, but in the same general time frame as mobile contaminants of Category 1 wastes. However, because of the continued release from Category 3 wastes, impacts are still of interest at the longest times calculated (20,000 years after facility closure). The impacts from glass are insignificant at the times when the mobile contaminant impacts from Category 1 or 3 wastes peak, but the impacts plateau for longer times (greater than 4,000 years after facility closure).

The peak groundwater impacts are due to Category 1 waste. The impacts from Category 1, Category 3 and glass wastes are comparable at 10,000 years. Because only a relatively few Category 1 packages are expected to drive the results (i.e., those packages with high $^{99}$Tc or $^{129}$I content), the amount of Category 1 waste accepted is manageable (e.g., these wastes can be disposed as Category 3 waste, if necessary). Impacts from melter disposal are minor relative to impacts from other wastes because their relatively small inventory is assumed to be contained in glass.

The contaminant groundwater impacts for ILAW-glass disposal are about five times higher than those presented in the base analysis case of the *Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version* (Mann et al. 2001), but still below performance objectives. The key drivers are increased $^{99}$Tc inventory due to the elimination of the Tc separations process from the WTP (Schepens 2003), decreased groundwater dilution due to the placement of the disposal trenches further towards the southern end of the disposal site, and the decrease in contaminant release due to the larger size of the containers (i.e., small surface to volume). Additional analyses and assumptions that could reduce the estimated impacts (such as the estimated impacts from a two-dimensional modeling of the near-field (compared to one-dimensional modeling [an improvement from the 2001 ILAW PA and the IDF analysis by about

**Figure 1. Time Dependence of the Estimated Farmer Scenario All-Pathways Dose at a Well 100 m Down-gradient from the Disposal Facility. The performance objective is 25 mrem/yr.**




a factor of 25]) and better waste form performance) have not been included in this IDF risk analyses. These improvements will be explicit in the 2005 IDF PA.

The impacts for the groundwater pathway for solid waste disposal are similar to those presented in the latest annual summary (Van Leuven 2003). A straightforward comparison with the burial ground analysis is not plausible because several key assumptions affecting estimated impacts are different, leading to both increases and decreases in these estimates. However, in both Van Leuven 2003 and Mann et al. 2003a, performance objectives are satisfied.

The estimated all-pathways doses are significantly lower than the performance objectives during the first 10,000 years (see Table 4). At the DOE time of compliance (1,000 years) the estimated impact is insignificant.

The greatest contributors to the peak all-pathways dose are mobile contaminants from the Category 1 wastes, which peak in the few thousand-year time frame (see Figure 1). Category 3 wastes show a peak at about the same time. For times exceeding 10,000 years, the contributions

**Table 4. Comparison of Estimated Impacts with Performance Objectives for Protecting the General Public. The DOE time of compliance is 1,000 years.**

| Performance Measure | Performance Objective | Estimated Peak Impact During First 1,000 years [(a)] | Estimated Peak Impact During First 10,000 years [(b)] |
|---|---|---|---|
| All-pathways [mrem in a year] | 25.0 | | |
| Farmer Scenario | | $1.2 \times 10^{-10}$ | 1.8 |
| Residential Scenario | | $0.73 \times 10^{-10}$ | 1.1 |
| Industrial Scenario | | $0.22 \times 10^{-10}$ | 0.32 |
| Incremental Lifetime Cancer Risk (Chemicals)* | $10^{-5}$ | $7.9 \times 10^{-17}$ | $5.6 \times 10^{-7}$ |
| Hazard Index (Chemicals)* | 1.0 | $1.8 \times 10^{-11}$ | 0.12 |

* Based on chromium, nitrate, and uranium inventory
[(a)] Peak impacts occur at the end of the 1,000 year period
[(b)] Peak impacts occur at about 2,400 years after closure

from the mobile contaminants from glass, contaminants from Category 3 wastes, and the slightly retarded contaminants from Category 1 wastes (uranium isotopes and $^{237}Np$) are comparable. Up to about 5,000 years, the major contributors to the farmer scenario all-path-ways estimated dose are $^{129}I$ (~90%) and $^{99}Tc$ (~10%). At 10,000 years, $^{237}Np$ contributes 44% of the all-pathways dose, $^{99}Tc$ contributes 35%, $^{129}I$ contributes 17%, and other radionuclides contribute 4%.

**c. Other impacts.**

Other impacts (inadvertent intruder, air, and surface water) were also calculated and found to be small. Tables 5a/b displays the impacts for the inadvertent intruder and for air resources. The impacts for surface water are much smaller than for groundwater as groundwater is the source of any surface water contamination and the point of compliance for the surface water (~10 miles) is much farther away than is the evaluated point of analysis for groundwater (100 meters).

**Table 5a. Comparison of Estimated Impacts with Performance Objectives for Protecting the Inadvertent Intruder. The time of compliance starts at 500 years.**

| Performance Measure | Performance Objective | Estimated Impact at 500 years |
|---|---|---|
| Acute exposure [mrem] | 500.0 | 1.06 |
| Continuous exposure [mrem in a year] | 100.0 | 26.8 |

**Table 5b. Comparison of Estimated Impacts with Performance Objectives for Protecting Air Resources. The DOE time of compliance is 1,000 years. The point of compliance is just above the disposal facility.**

| Performance Measure | Performance Objective | Estimated Impact at 1,000 years |
|---|---|---|
| Radon [pCi $m^{-2}$ $second^{-1}$] | 20.0 | 2.7 |
| Other radionuclides ($^{3}H$ and $^{14}C$) [mrem in a y] | 10.0 | 0.44 |

## 3. Supplemental ILAW

The initial plan was to produce all ILAW in the Waste Treatment Plant as a glass waste form. In order to accelerate production of ILAW, the Office of River Protection is investigating supplemental methods of producing ILAW. After a process of down selection, bulk vitrification is the leading candidate. In this process, dried waste is mixed with soil and heated by electrodes in a metal box. The entire box is then disposed. As part of the down selection process, a risk assessment, *Risk Assessment Supporting the Decision on the Initial Selection of Supplemental ILAW Technologies* (Mann et al. 2003c), investigated the long-term environmental impacts from both the ILAW product and the associated secondary waste (which is assumed processed through the Effluent Treatment Facility and then grouted) using the data and methods of the 2001 ILAW PA (Mann et al. 2001) and the IDF Risk Assessment (Mann et al. 2003a). The 2003 ILAW PA Annual Summary (Mann 2003b) presented a summary of the results, which are repeated in Table 6.

**Table 6. Estimated Groundwater Impacts (Beta/Gamma Drinking Water Doses expressed in mrem-EDE/yr) from Disposal of Immobilized Low-Activity Waste at IDF. Each waste form is assumed to have 25% of the total inventory. The point of calculation is a well 100meters down gradient. The performance objectives is 4 mrem/yr**

| Material | Product Only | Secondary Waste[(a)] | Total |
|---|---|---|---|
| WTP glass | 0.101 | 0.628 | 0.729 |
| Bulk vitrification | 0.000015 | 0.628 | 0.628 |
| Cast stone | 2.64 | 0.00074 | 2.64 |
| Steam Reforming Material | 0.00055 | 0.628 | 0.628 |

(a) Secondary waste is assumed to be disposed of as Category 3 waste, i.e., the waste is encapsulated with grout.

### 4. Summary

Based on the results of the Integrated Disposal Facility Risk Assessment (Mann et al. 2003a) and the Risk Assessment Supporting the Decision on the Initial Selection of Supplemental ILAW Technologies (Mann et al. 2003c), larger impacts are estimated than seen in the Hanford Immobilized Low-Activity Waste Performance Assessment: 2001 Version (Mann et al. 2001). These changes are primarily due to the new waste forms (mainly the secondary waste from the production of ILAW). This waste was formerly destined for Hanford 200 West Area Solid Burial Grounds. Impacts from such wastes are estimated to be lower in the IDF location due to increased groundwater flow rates.

The effects of new data contained in the data packages for the 2005 IDF PA on long-term impacts will be discussed in the following sections. The expected new estimates will be contrasted not only to the 2001 ILAW PA, but also to the IDF Risk Assessment, and the down selection risk assessment.

## B. PERFORMANCE OBJECTIVES

The performance objectives currently being used by the IDF PA activity are those documented for the 2005 Immobilized Low-Activity Waste Performance Assessment, *Performance Objectives for the Hanford Immobilized Low-Activity Waste (ILAW) Performance Assessment* (Mann 2002b). They are basically unchanged from the 2001 ILAW PA (Mann et al. 2001). They are based on federal and State of Washington relevant and appropriate laws and regulations.

The most significant performance objectives are:

- The all-pathways dose objectives of 25 mrem effective dose equivalent (EDE) in a year
- The drinking water dose objectives for beta and gamma emitters of 4 mrem EDE in a year
- The incremental lifetime cancer risk due to chemicals of $10^{-5}$/yr
- The inadvertent intruder all-pathways chronic dose objectives for a post-driller resident of 100 mrem EDE in a year.

The first three objectives are evaluated at a point 100 meters down gradient from the disposal trench and for times of 1,000 and 10,000 years after closure. The last objective is evaluated at the disposal facility at 500 years (consistent with earlier Hanford performance assessments [Wood et al. 1995, Wood et al. 1996, and Mann et al. 2001]).

## C. DISPOSAL FACILITY DESIGN

The facility design (a conceptual design) used in the 2001 ILAW PA consisted of 6 trenches (260 m long by 80 m wide by 10 m deep). The current design (Dehmar 2004a and 2004b) consists of a lined landfill, approximately 410 m (1345 ft) wide by approximately 501 m (1645 ft) in length by up to 13.2 m (43.3 ft) deep. The landfill is separated into two separate cells that are each 205 m wide by approximately 501 m in length. The locations of the two designs mostly overlap each other. There is expected to be relatively little (less than a factor of two) change in impacts caused by the design changes.

# D. INVENTORY

## 1. Overview

The *Inventory Data Package for the 2005 Integrated Disposal Facility Performance Assessment* (Puigh et al. 2004b) presents the most up-to-date estimate of wastes destined for IDF. However, inventory information is still evolving. Major changes from the 2001 ILAW PA come from new

- New tank waste inventories (which translate in new inventories for ILAW),
- Introduction of secondary waste from the production of ILAW,
- Introduction of other Hanford solid waste, and
- Introduction of off-site solid waste from the DOE complex.

In addition, work is continuing to update the Best Basis Inventory which describes the official inventory of waste in tanks and to better describe the process flow sheets of treatment of tank waste. This new work will be completed by the spring of 2005 and will be used in the 2005 IDF PA.

## 2. New Tank Waste Inventories

Inventories for the ILAW product and the ILAW secondary waste, the two waste streams that contribute most significantly to impacts from IDF, are directly derived from the inventories in Hanford's large underground tanks. Since the 2001 ILAW PA, estimates for these tank inventories have changed as seen in Table 7. The current estimates are lower. The change in $^{99}$Tc arises from the recognition that about 25% of the $^{99}$Tc was sent to DOE's Fernald facility decades ago as part of uranium material. The change in $^{129}$I arises from recognition of the limited amount of $^{129}$I produced in the Hanford reactors (49.4 Ci) and from process losses rather the use of upper limits for tank waste measurements. The change in $^{238}$U comes from improved measurements of tank waste samples.

**Table 7. Changes in Tank Waste Inventories**

| Contaminant | 2001 ILAW PA | Inventory Data Package for 2005 IDF PA | Current Estimate / 2001 Estimate |
|---|---|---|---|
| $^{99}$Tc | 28,900 Ci | 25,100 Ci | 0.87 |
| $^{129}$I | 101 Ci | 31.8 Ci | 0.31 |
| $^{238}$U | 328 Ci | 305 Ci | 0.93 |

These changes lower the impacts estimated in the 2001 ILAW PA, the IDF risk assessment, and the down selection risk assessment for $^{99}$Tc since most of the $^{99}$Tc is predicted to be incorporated into the ILAW glass waste form. The most important contributor to long-term risk in the latter two documents is $^{129}$I. The latest inventory estimate (Puigh et al. 2004b) places 18 to 26.5 Ci of $^{129}$I into the secondary waste stream. The estimated risk in the IDF risk assessment was due predominantly to 1 Ci of $^{129}$I in untreated waste and 6 Ci $^{129}$I in a grouted waste form. The down-selection risk assessment considered 22 Ci $^{129}$I in a grouted waste form and resulted in a drinking water dose of 0.6 mrem/y.

## 3. Secondary Waste from ILAW Production

This waste stream was not analyzed in the 2001 ILAW PA, as the disposal facility only would contain ILAW product. This secondary waste stream was destined from the Hanford Site Solid Waste Burial Grounds. Table 8 displays the inventories used in the *Integrated Disposal Facility Risk Assessment* (Mann et al. 2003a) and in the *Risk Assessment Supporting the Decision on the Initial Selection of Supplemental ILAW Technologies* (Mann et al. 2003c) as well as in the *Inventory Data Package for the 2005 Integrated Disposal Facility Performance Assessment* (Puigh et al. 2004b). The biggest changes are in the $^{129}$I inventory. The value used in the IDF risk assessment came from required generator reports early in the process design of the Waste Treatment Plant. More iodine is now expected to go into secondary waste. Most of the change (over 95%) from the down selection risk assessment and the current estimate arises from the reduced $^{129}$I inventory in tank wastes. The changes for the inventory of other key contaminants fluctuate because of process design changes and are relatively small.

**Table 8. Changes in Secondary Waste from ILAW Production**

(All ILAW produced at the Waste Treatment Plant)

| Contaminant | IDF RA | Down Selection RA [a] | Inventory Data Package for 2005 IDF PA |
|---|---|---|---|
| $^{99}$Tc | 19 Ci | 29 Ci | 20 Ci |
| $^{129}$I | 5 Ci | 88 Ci | 26.5 Ci |
| $^{238}$U | 0.487 Ci | Not reported | 0.03 Ci |

[a] Risk impacts in the down-selection risk assessment estimated for 1/4$^{th}$ the inventory in each waste type. Inventory based on the 2001 ILAW PA for comparison with the 2001 ILAW PA and the IDF RA.

Based on the new estimates of inventory, the results from the IDF risk assessment change, but the estimated risks over 10,000 years would still be below the established performance objectives if other parameters impacting groundwater concentrations remain unchanged.

## 4. Other Solid Waste

This waste stream was not analyzed in the 2001 ILAW PA. This waste stream is currently and was destined to continue to be disposed in the Hanford Site Solid Waste Burial Grounds, before the record of decision established IDF as the disposal facility for future disposal. Such waste was analyzed in the IDF risk assessment. Table 9 displays the inventories used in the *Integrated Disposal Facility Risk Assessment* (Mann et al. 2003a) as well as in the *Inventory Data Package for the 2005 Integrated Disposal Facility Performance Assessment* (Puigh et al. 2004b). The values in the inventory data package reflect the limitations on the importation of off-site waste established in the “Record of Decision for the Solid Waste Program, Hanford Site, Richland, WA: Storage and Treatment of Low-Level Waste and Mixed Low-Level Waste; Disposal of Low-Level Waste and Mixed Low-Level Waste, and Storage, Processing, and Certification of Transuranic Waste for Shipment to the Waste Isolation Pilot Plant” (DOE 2004a). Most (greater than 97%) of the uranium comes from off-site waste.

**Table 9. Changes in Other Solid Waste Inventories**

| Contaminant | IDF RA | Inventory Data Package for 2005 IDF PA |
|---|---|---|
| $^{99}Tc$ | 91 Ci | 62 Ci |
| $^{129}I$ | 2 Ci | 0.14 Ci |
| $^{238}U$ | 1.5 Ci | 137 Ci |

Because leached uranium is retarded, most of the groundwater impacts come from $^{99}Tc$ and $^{129}I$. However, the increase in uranium inventory will produce higher impacts in times greater than 10,000 years. Moreover, most of the uranium will be encapsulated in grout, which greatly reduces its release rate because of chemical absorption. This effect may be off-set by a lower estimated linear absorption factors ($K_d$s) uranium forms very insoluble solids with fresh cement minerals.

## E. RECHARGE

Estimates for the recharge rate (or the rate at which moisture passes through the near-surface soil) have changed based on the work documented in the *Recharge Data Package for the Integrated Disposal Facility Performance Assessment* (Fayer and Szecsody 2004). Table 10 displays the values previously used and the current estimates.

The biggest differences are the reduction of the natural recharge rate from 4.2 mm/yr to 0.9 mm/yr, the elimination of the side slope in the barrier design, and the reduction of the recharge rate through the degraded barrier. The IDF site has two types of soils overlaying it. Previous analyses thought that these two soils (Rupert Sand and Burbank Loamy Sand) had different recharge rates (0.9 and 4.2 mm/yr, respectively). Field measurements (see Fayer and Szecsody 2004) have shown that, in fact, the recharge through these two soils is similar, being 0.9 mm/yr. Because of the topography of the site, the detailed design of the IDF does not contain a side slope to the surface barrier. The most important change is the reduction of the recharge through the degraded barrier from natural conditions (4.2 mm/yr in the 2001 ILAW PA) to a value consistent with how the barrier is expected to degrade (0.1 mm/yr). A number of failure mechanisms were investigated, but they do not lead to a value larger than 0.1 mm/yr.

**Table 10. Changes in Recharge Rates**

| Time Period | 2001 ILAW PA | Recharge DP for 2005 IDF PA |
|---|---|---|
| Natural Condition (<2004) | 4.2 mm/yr | 0.9 mm/yr |
| Construction/Operation (2004-2032) | 55 mm/yr | 55 mm/yr |
| Surface Barrier (2032-2532) | 0.1 mm/yr (a) | <0.1 mm/yr |
| Surface Barrier Degrades (>2532) | 4.2 mm/yr (a) | 0.1 mm/yr |

(a) The side slope of the barrier has a recharge of 55 mm/yr.

The consequence of decreased recharge through the barrier is very important. Except for wastes with very long release rates (such as glass), the estimated peak groundwater risks are proportional to the long-term recharge rate. For glass wastes, there will be a negligible change in estimated impacts. The 2005 IDF PA will analyzed system performance due to uncertainties in recharge values as well as uncertainties in other important parameters.

## F. GEOLOGY

Five additional boreholes (on the east and south sides of the facility) have been drilled since the 2001 ILAW PA. The analyses on the samples taken from the borehole confirm the geology in the 2001 ILAW PA. The geology of the IDF site is described in *Geologic Data Package for the 2005 Integrated Disposal Facility Performance Assessment* (Reidel 2004).

## G. HYDROLOGY

The hydraulic properties of numerous borehole samples were measured confirming the values used in the 2001 ILA PA. In addition, hydraulic properties for Hanford gravels were estimated through the use of air pressure measurements in one of the new boreholes and through the use of analogues at the Hanford Site. Measurements on expected backfill materials have a small change in properties. These results are documented in *Far-Field Hydrology Data Package for the Integrated Disposal Facility* (Khaleel 2004) and in *Near-Field Hydrology Data Package for the 2005 Integrated Disposal Facility Performance Assessment* (Meyer et al. 2004).

No important differences are expected due to the far-field hydraulic parameters. However, preliminary calculations indicate increased moisture content near glass, increasing release rate several fold for same recharge.

## H. GEOCHEMISTRY

Substantial efforts by many projects at Hanford have been expended to understand how contaminants transport through the vadose zone. The latest information relevant to the IDF site is documented in *Geochemical Data Package for the2005 Hanford Integrated Disposal Facility Performance Assessment (IDF PA)* (Krupka et al. 2004). A noteworthy conceptual difference with earlier work is the introduction of two chemical environments, one impacted by the sodium from the ILAW glass (expected to have 20% $Na_2O$ by weight) and the other not being impacted. Table 11 displays the change in linear absorption factors ($K_d$s) values from the 2001 ILAW PA to the current estimates. These estimates (along with reasonable conservative values and a range of values that are documented in the data package) are based on Hanford soils-specific laboratory measurements as well as literature searches. The data package also recommends values for various other less important geologic contaminants for the specified site environments.

**Table 11. Changes in $K_d$ Values (in mL/g) for Hanford Sands**

| Contaminant | 2001 ILAW PA (mL/g) | Geochemistry DP for 2005 IDF PA (mL/g) | |
|---|---|---|---|
| | | Na-Impacted | Non-Na Impacted |
| $^{99}Tc$ | 0.0 | 0.0 | 0.0 |
| $^{129}I$ | 0.0 | 0.1 mL/g | 0.25 mL/g |
| $^{238}U$ | 0.6 mL/g | 0.2 mL/g | 1 mL/g.0 |

The mobility of $^{99}Tc$, the key contaminant of the 2001 ILAW PA), remains unchanged. Therefore, the risk results of the 2001 ILAW PA will remain unimpacted by the changing $K_d$s. However, peak impacts in the IDF risk assessment and in the Down Selection risk assessment should be lowered as the new $K_d$ values will lead to lower estimated impacts for $^{129}I$, the key contaminant in those assessments. The impacts due to the changed uranium mobility are unclear (although uranium impacts should remain below $^{99}Tc$ and $^{129}I$ impacts) as part of the uranium inventory (that associated with ILAW) will be more mobile, while the other part (that associated with untreated low-level waste) will be less mobile. It should be noted that due to the strong affinity of uranium to cement, uranium encapsulated in grouts will not have major groundwater impacts.

## I. WASTE FORMAT RELEASE

There are four general types of wastes planned for possible disposal at IDF:

- ILAW produced by vitrification in the Waste Treatment Plant
- ILAW produced by bulk vitrification
- Grouted waste
- Untreated waste (i.e., waste not requiring treatment prior to final disposal)

The follow sections treat each of these waste forms.

### 1. ILAW glass

The 2001 ILAW PA (Mann et al. 2001) used the properties of LAWABP1 to estimate the release properties of the ILAW glass produced by the Waste Treatment Plant. The 2005 IDF PA will use the properties of glass developed by the Waste Treatment Plant contractor: LAWA44, LAB45, and LAWAC22. A large suite of tests, as defined in the *A Strategy to Assess Performance of Selected Low-Activity Waste Forms in an Integrated Disposal Facility* (McGrail et al. 2003), was used to define the properties. The document *Waste Form Release Data Package for the 2005 Integrated Disposal Facility Performance Assessment* (Pierce et al. 2004) documents the parameters and justifies their selection.

A large number of parameters are needed to simulate release from glass. The major parameters are shown in Table 12. Because the release of contaminants is a time-dependent, location-dependent function of evolving environmental conditions, it is not possible to predict by just looking at the parameters what the release rate will be. However, it is expected that the releases from the new glass compositions will be lower than from LAWABP1.

### 2. Bulk Vitrification

Laboratory and full scale tests are being performed outside of the performance assessment activity. However, a close cooperative effort exists between the two activities. A data package is expected to be issued by the end of calendar year 2004 for the parameters associated with the bulk vitrification waste form.

**Table 12. Summary of Best Estimate Rate Law Parameters for LAWA44, LAWB45, and LAWC22 Glasses at 15ºC.**

| Parameter | Meaning | LAWABP1 | LAWA44 | LAWB45 | LAWC22 | Comments |
|---|---|---|---|---|---|---|
| $\vec{k}$ | forward rate constant (g m$^{-2}$ d$^{-1}$) | $3.4 \times 10^6$ | $1.3\times10^4$ | $1.6\times10^4$ | $1.0 \times 10^5$ | |
| $K_g$ | apparent equilibrium constant for glass based on activity product a[$SiO_2$(aq)] | $4.9\times10^{-4}$ | $5.45\times10^{-4}$ | $5.24\times10^{-4}$ | $5.25 \times 10^{-4}$ | |
| $\eta$ | pH power law coefficient | 0.35 | 0.49 ±0.08 | 0.34 ±0.03 | 0.42 ±0.02 | |
| $E_a$ | activation energy of glass dissolution reaction (kJ mol$^{-1}$) | 68 | 60 ±7 | 53 ±3 | 64 ±2 | |
| $\sigma$ | Temkin coefficient | 1 | 1 | 1 | 1 | Assigned constant |
| $r_x$ | Na ion-exchange rate (mol m$^{-2}$ s$^{-1}$) | $3.4\times10^{-11}$ | $5.3\times10^{-11}$ | 0 | $1.2 \times 10^{-10}$ | No detectable ion exchange rate for LAWB45 |

## 3. Grouted Waste

The 2001 ILAW PA did not consider grouted waste forms. They were included in the IDF risk assessment and the Down Selection risk assessment. Values for the 2005 IDF performance assessment will be based on the values in the *Waste Form Release Data Package for the 2005 Integrated Disposal Facility Performance Assessment* (Pierce et al. 2004). These are displayed in Table 13.

**Table 13. Changes in Diffusion Coefficients (cm$^2$/s) for Grout**

| Contaminant | IDF RA | Down Selection RA (a) | Waste Form Release Data Package for 2005 IDF PA (most probable values) |
|---|---|---|---|
| $^{99}$Tc | $1x10^{-11}$ | $1x10^{-11}$ | $5x10^{-10}$ |
| $^{129}$I | $1x10^{-11}$ | $1x10^{-11}$ | $2.6x10^{-9}$ |
| $^{238}$U | Not reported | Not reported | $1x10^{-11}$ |

(a) This values are for the secondary waste, not for CastStone.

The diffusion coefficients values to be used in the 2005 IDF performance assessment are larger than in earlier analyses for Tc and I. This should result in larger releases from the facility. However, because of the broad temporal dependence of such a release, how this will translate into groundwater impacts still needs to be determined. At worst, the change in dose impacts will go as the square root of the ratio of the diffusion coefficients.

### 4. Untreated Waste

The 2001 ILAW PA did not consider waste that is untreated (that is, waste having an inventory of contaminants low enough that treatment is not required for final disposal). Examples of untreated waste are lightly radiologically contaminated clothes or soils placed into drums. They were included in the IDF risk assessment (Mann 2003a) and the Down Selection risk assessment (Mann 2003b). Since the release duration of untreated wastes is fast compared to the travel time through the vadose zone to groundwater, past calculations have shown that any changes of the release rate from untreated wastes will have no effect on estimated groundwater impacts.

## J. GROUNDWATER FLOW

The 2005 IDF performance assessment will use the same groundwater calculations as were used in the 2001 ILAW PA, IDF risk assessment (Mann 2003a), and the Down Selection Risk assessment (Mann 2003c). These values come from the Hanford Site wide Groundwater Model. This model is being upgraded, verified, and validated.

## K. DOSIMETRY

The dosimetry data package for the 2001 ILAW PA (Rittmann 1999) was updated in order to support Hanford tank performance assessments. The new document, *Exposure Scenarios and Unit Dose Factors for the Hanford Tank Waste Performance Assessment* (Rittmann 2004), includes new post-intrusion scenarios, additional chemicals, and updated exposure parameter values.

The new post-intrusion scenarios correspond to a rural farmer with a cow and to a commercial farmer, the scenarios for current land use in upland areas surrounding the Hanford Site. Both scenarios would generate lower inadvertent intruder doses than estimated in the 2001 ILAW PA. In addition, exposure parameters were generated for the individual pathways making up the exposure scenario.

To support tank closure activities, parameters for additional chemicals were added to the dosimetry data package. Such additions do not impact the radiological portion of the performance assessment and are not expected to have any substantial impact on the results of the chemical portion, because of their low expected inventories.

Changes were also made in the exposure parameters reflecting new information from the U.S. Department of Agriculture, the Environmental Protection Agency, the International Atomic Energy Agency, and the International Commission on Radiation Protection. The changes are not expected to materially affect total system results, but may change estimates of individual exposure pathways.

In summary, the biggest changes from the new dosimetry analyses will result from the change in scenario selection.

# VII. CONCLUSIONS

As noted in this report, new information has been obtained since the preparation of the 2001 ILAW PA. The new information is documented in a series of peer-reviewed data packages*. Considering the results of data collection and analysis, the conclusions of the 2001 version of the ILAW PA (Mann et al. 2001) for the WTP glass remain valid, that the disposal of ILAW glass is protective of long-term human health and the environment. These are the same conclusions that appeared in the draft version of the 2001 ILAW PA that was approved (DOE 2001).

However, with the addition of more waste types into the IDF, impacts at the IDF will be significantly higher than shown in the 2001 ILAW PA. Nevertheless, the impacts are estimated not to exceed performance objectives. Moreover, the additional waste streams have already been approved for disposal at Hanford (DOE 2001) and the impacts at the IDF site should be lower than at the already approved Hanford Site solid wastes disposal facilities.

Therefore, it is concluded that the expected impacts from waste disposal at the Hanford Site Integrated Disposal Facility will remain below performance objectives. A full performance assessment of the Integrated Disposal Facility is expected to be sent to DOE headquarters for approval in the summer of 2005.

* The values that will be used in the base analysis case of the 2005 IDF performance assessment will be determined by the Hanford Configuration Management Board, a group established in November 2004.

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